

24 May 1968

SUPERSEDING:

See Section 6

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM

TYPES 2N464, 2N465, 2N467

1. SCOPE

1.1 Scope. - This specification covers the detail requirements for germanium, PNP, transistors for use in low-power, amplifier applications in compatible electronic-equipment circuits. (See 3.4 and 6.2b herein.)

1.2 Outline and dimensions. - See Fig. 1 herein. (TO-5)

1.3 Maximum ratings. - (At $T_A = +25^{\circ}\text{C}$, unless otherwise specified):

	P_T 1/	V_{CBO}	V_{CEO} 2/	V_{EBO}	I_C	I_{CBO}	I_{EBO}	T_{stg}
	mW	Vdc	Vdc	Vdc	mAdc	μAdc	μAdc	$^{\circ}\text{C}$
2N464	150	-40	-40	-12	50	-15	-6	-65 to +100
2N465	150	-40	-30	-12	50	-15	-6	-65 to +100
2N467	150	-35	-15	-12	50	-10	-6	-65 to +100

1/ For $T_A > +25^{\circ}\text{C}$, derate linearly at $2.0 \text{ mW}/^{\circ}\text{C}$.

2/ Pulsed (see 4.3.1 herein).

1.4 Particular electrical characteristics. - (At $T_A = +25^{\circ}\text{C}$, unless otherwise specified):

	h_{fe}		f_{hfb}		h_{ib}		h_{ob}		C_{obo}		NF	
	at: $f = 1\text{kHz}$ $V_{CB} = -6\text{Vdc}$ $I_E = 1 \text{ mAdc}$		at: $f = 1\text{kHz}$ $V_{CB} = -6\text{Vdc}$ $I_E = 1 \text{ mAdc}$		at: (See Table I herein)		at: (See Table I herein)		at: (See Table I herein)		at: (See Table I herein)	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	---	---	MHz	MHz	ohms	ohms	μmho	μmho	pf	pf	db	db
2N464	14	33	0.4	---	18	45	---	1.0	---	20	---	20
2N465	27	66	0.5	---	18	45	---	1.0	---	20	---	20
2N467	110	260	0.7	---	18	45	---	1.0	---	20	---	20

FSC-5961

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATIONS

MILITARY

MIL-S-19500	Semiconductor Devices, General Specification For
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STANDARDS

MILITARY

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-1276	Leads, Weldable, for Electronic Component Parts

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both the title and number or symbol should be stipulated when requesting copies.)

3. REQUIREMENTS

3.1 General. - Requirements for the transistors shall be in accordance with Specification MIL-S-19500, and as otherwise specified herein.

3.2 Abbreviations and symbols. - The abbreviations and symbols used herein are defined in Specification MIL-S-19500.

3.3 Design and construction. - The transistor shall be of the design, construction, and physical dimensions specified on Figure 1.

3.3.1 Terminal arrangement. - The terminal arrangement on the transistor shall be as indicated in Figure 1.

3.3.2 Operating position. - The transistor shall be capable of proper operation in any position.

3.3.3 Terminal-lead length. - Terminal-lead length(s) other than that established in Figure 1 herein may be furnished when specified in the contract or order (see 6.3a herein) where the devices covered herein are required directly for particular equipment-circuit installation. Where such other lead lengths are required and provided, it shall not be construed as affecting adversely the Qualified-product status of the device, or applicable JAN marking.

3.3.4 Terminal-lead material and finish. - The terminal lead material shall be Type K (Kovar) or Type F (Alloy 52) conforming to requirements in Standard MIL-STD-1276. The terminal-lead finish shall be gold (per pertinent requirements in Standard MIL-STD-1276); however, if so specified in the contract or order, the lead-material finish may be tin, or tin-coating over gold. This tin-finish requirement shall not be construed as affecting adversely the Qualified-product status of the device, or applicable JAN marking (See 6.3b herein).

3.3.4.1 Selectivity of terminal-lead material. - Where choice of lead material (see 3.3.4 above) is desired, stipulation of the particular material shall be made in contract or order. (See 6.3b herein.)

3.4 Performance characteristics. - The transistor performance characteristics shall be as specified in Tables I, II, and III herein. Except where specifically differentiated for respective transistor types (see 1.3, 1.4, and Tables I, II, and III herein), the performance requirements, including characteristics, ratings, and test conditions, apply equally to all transistor types covered herein.

3.5 Marking. - Except as otherwise specified herein, marking shall be in accordance with Specification MIL-S-19500. If any specification-requirements waiver has been granted, the product-identification marking shall consist of the "classification" type designation only. The "manufacturer's identification" and "country of origin" may, at option of the manufacturer, be omitted from being marked directly on the semiconductor device covered herein.

4. QUALITY ASSURANCE PROVISIONS

4.1 General. - Except as otherwise specified herein, the responsibility for inspection, general procedures for acceptance, classification of inspection, and inspection conditions and methods of test shall be in accordance with Specification MIL-S-19500, Quality Assurance Provisions.

4.2 Qualification and acceptance inspection. - Qualification and Quality Conformance inspection shall be in accordance with Specification MIL-S-19500, Quality Assurance Provisions, and as otherwise specified herein. Groups A, B, and C inspection shall consist of the examinations and tests specified in Tables I, II, and III respectively, herein. Quality Conformance inspection shall include inspection of Preparation for Delivery (see 5.1 herein.)

4.2.1 Specified LTPD for Subgroups. - The LTPD specified for a subgroup in Tables I, II, and III herein shall apply for all of the tests, combined, in the subgroup.

4.2.2 Qualification relative to lead-material finish. - Devices constructed with either of the lead-material finishes established herein (see 3.3.4) may be submitted for Qualification approval. The type of finish used by the manufacturer shall be stipulated in the submittal data for the product to be tested.

4.2.3 Acceptance inspection of lots containing multiple transistor types. - For lots containing more than one transistor type covered herein, subsection of adequate samples on a subplot basis to tests in accordance with a and b below, will be acceptable. Normally applicable acceptance criteria shall apply to acceptability determination for the entire submitted lot.

- a. Each transistor type (subplot) shall be subjected to all Group A tests and to all Group C tests (when the Group C tests are incumbent to be performed on the transistor type concerned); plus:
- b. The transistor type (subplot) at the highest D.C. Current Gain level shall be subjected to all applicable Group B tests except Life tests.

4.2.4 Group B - Group C life test samples. - Samples that have been subjected to Group B, 340-hour life test may be continued on test for 1000 hours in order to satisfy Group C life test requirements. These samples shall be predesignated, and shall remain subjected to the Group C 1000-hour evaluation after they have passed the Group B, 340-hour acceptance criteria; hereto, the cumulative total of failures found during 340-hour test and during the subsequent interval up to 1000 hours on these samples shall be computed for 1000-hour acceptance criteria.

4.2.5 Group C testing. - Group C tests shall be performed on a lot every 6 months. (See Table III herein). The contractor shall, throughout the course of a contract or order, permit the Government representative to scrutinize all test data and findings covering manufacturer's test program on Group C characteristics and parameters for the product concerned. Upon determination by the Government inspector (in advance of Group C, 6-month, test results) that Group C parameters are not being adequately met, the Government inspector may require lot-by-lot inspection, normally for a minimum of 3 consecutive lots, to be performed for required Group C tests.

4.2.6 Disposition of sample units. - Sample units that have been subjected to Group B, Subgroup 2, 4, and 5 tests shall not be delivered on the contract or order. Sample units that have been subjected to and have passed Group B, Subgroup 1, 3, 6, and 7 and all Group C tests (these tests to be considered non-destructive), may be delivered on the contract or order provided that, after Group B and C inspection is terminated, those sample units are subjected to and pass Group A inspection. Defective units from any sample group that may have passed group inspection shall not be delivered on the contract or order until the defect(s) has been remedied to the satisfaction of the Government.

4.3 Particular examination and test requirements. -

4.3.1 "Pulsed"-conditions measurements. - Measurements required herein to be effected under pulsed conditions, shall be made in accordance with "Pulse Measurements" requirements in Section 4 of MIL-STD-750.

4.3.2 Interval for End-Point Test measurements. - All applicable End-Point Test measurements shall be performed within 96 hours after sample units have been subjected to required physical-mechanical or environmental test(s).

4.3.3 Mechanical damage resulting from tests. - Except for intentionally deforming, mutilating, or dismembering mechanical-stress tests to which samples are subjected, there shall be no evidence of mechanical damage to any sample unit as a result of any of the Groups A, B, or C tests.

TABLE I. GROUP A INSPECTION.

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST 1/	CONDITIONS	LTPD	SYMBOL	LIMITS		UNIT
					MIN.	MAX.	
2071	<u>Subgroup 1</u>		10				
	Visual and mechanical examination	---		---	---	---	---
3036	<u>Subgroup 2</u>		5				
	Collector-base cutoff current:	Bias Cond.D					
	2N464	$V_{CB} = -40V_{dc}$		I_{CBO}	---	-15	μA_{dc}
	2N465	$V_{CB} = -40V_{dc}$		I_{CBO}	---	-15	μA_{dc}
3036	Collector-base cutoff current	$V_{CB} = -35V_{dc}$		I_{CBO}	---	-10	μA_{dc}
		Bias Cond. D		I_{CBO}	---	-6	μA_{dc}
3061	Emitter-base cutoff current	$V_{CB} = -12V_{dc}$					
		Bias Cond. D		I_{EBO}	---	-6	μA_{dc}
3001	Collector-base breakdown voltage:	Bias Cond. D					
	2N464	$I_C = -10\mu A_{dc}$		BV_{CBO}	-40	---	Vdc
	2N465			BV_{CBO}	-40	---	Vdc
	2N467			BV_{CBO}	-35	---	Vdc
3011	Collector-emitter breakdown voltage:	Bias Cond. D					
	2N464	$I_C = 2 mA_{dc}$		BV_{CEO}	-40	---	Vdc
	2N465	Pulsed; 2/		BV_{CEO}	-30	---	Vdc
	2N467			BV_{CEO}	-15	---	Vdc
3301	<u>Subgroup 3</u>		15				
	Small-signal short circuit forward-current transfer ratio cutoff frequency:	$V_{CB} = -6V_{dc}$					
	2N464	$I_E = 1 mA_{dc}$		f_{hfb}	0.4	---	MHz
	2N465	$f = 1 kHz$		f_{hfb}	0.5	---	MHz
	2N467			f_{hfb}	0.7	---	MHz

TABLE I. GROUP A INSPECTION - (Continued)

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST 1/	CONDITIONS	LTPD	SYMBOL	LIMITS		UNIT
					MIN.	MAX.	
	<u>Subgroup 3-(Cont'd)</u>						
3206	Small-signal short-circuit forward-current transfer ratio: 2N464 2N465 2N467	$V_{CB} = -6V_{dc}$ $I_E = 1 \text{ mA}_{dc}$ $f = 1 \text{ kHz}$		h_{fe} h_{fe} h_{fe}	14 27 110	33 66 260	--- --- ---
3236	Output capa- cittance (open circuit)	$V_{CB} = -6V_{dc}$ $f \geq 0.1 \leq 1.0\text{MHz}$ $I_E = 0$		C_{obo}	---	20	pf
3201	Small-signal short-circuit input impedance	$V_{CB} = -6V_{dc}$ $I_E = 1 \text{ mA}_{dc}$ $f \geq 0.1 \leq 1.0\text{MHz}$		h_{ib}	18	45	ohms
3216	Small-signal open circuit output admittance	$V_{CB} = -6 \text{ V}_{dc}$ $I_E = 1 \text{ mA}_{dc}$ $f = 1 \text{ kHz}$		h_{ob}	---	1.0	umho
3246	Noise figure	$V_{CB} = -2.5 \text{ V}_{dc}$ $I_E = 0.5 \text{ mA}_{dc}$ $R_L = 100 \text{ k ohms}$ $R_g = 100 \text{ ohms}$ 3/		NF	---	20	db
	<u>Subgroup 4</u>		15				
4/	High-temperature operation:	$T_A = +71^{\circ}\text{C}$ 5/					
3036	Collector-base cutoff current	Bias Cond. D $V_{CB} = -12V_{dc}$		I_{CBO}	---	-100	μA_{dc}
---	Low-temperature operation:	$T_A = -55^{\circ}\text{C}$ 5/					
3206	Small-signal short-circuit forward-current transfer ratio: 2N464 2N465 2N467	$V_{CB} = -6V_{dc}$ $I_E = 1 \text{ mA}_{dc}$ $f = 1 \text{ kHz}$		h_{fe} h_{fe} h_{fe}	7 14 50	--- --- ---	--- --- ---

TABLE I. GROUP A INSPECTION - (Continued)

- 1/ See 3.4 herein.
- 2/ See 4.3.1 herein.
- 3/ Quan-Tech test set, Model 311, or equivalent, shall be used.
- 4/ In this Subgroup, the sample units subjected to the High-Temperature Operation test shall be permitted to return to and be stabilized at room ambient temperature prior to their being subjected to the Low-Temperature Operation test.
- 5/ Measurement(s) shall be made after thermal equilibrium has been reached at the temperature specified.

TABLE II. GROUP B INSPECTION.

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST 1/	CONDITIONS	LTPD	SYMBOL	LIMITS		UNIT
					MIN.	MAX.	
	<u>Subgroup 1</u>		20				
2066	Physical dimensions	---		---	---	---	---
	<u>Subgroup 2</u>		15				
2026	Solderability	---		---	---	---	---
1051	Temperature cycling	Test Cond. A		---	---	---	---
1056	Thermal shock (glass strain)	Test Cond. A		---	---	---	---
<u>2/</u>	Seal(leak rate)	Test Cond. C Procedure III; Test Cond. A or B for Gross leaks		---	---	1×10^{-7} atm cc/sec	
1021	Moisture resistance	---		---	---	---	---
	<u>End Point Tests:</u>						
3036	Collector-base cutoff current:	Bias Cond. D					
	2N464	$V_{CB} = -40Vdc$		I_{CBO}	---	-15	μA_{dc}
	2N465	$V_{CB} = -40Vdc$		I_{CBO}	---	-15	μA_{dc}
	2N467	$V_{CB} = -35Vdc$		I_{CBO}	---	-10	μA_{dc}
3206	Small-signal short-circuit forward-current transfer ratio:	$V_{CB} = -6Vdc$ $I_E = 1 mA_{dc}$ $f = 1 kHz$					
	2N464			h_{fe}	14	33	---
	2N465			h_{fe}	27	66	---
	2N467			h_{fe}	110	260	---

MIL-S-19500/49C (EL)

TABLE II. GROUP B INSPECTION. - (Continued)

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST 1/	CONDITIONS	LTPD	SYMBOL	LIMITS		UNIT
					MIN.	MAX.	
	<u>Subgroup 3</u>		15				
2016	Shock	Non-operating 1500G 5 blows of 0.5 msec ea. in orienta- tions X1, Y1, Y2, Z1 (total = 20 blows)		---	---	---	---
2056	Vibration, variable frequency	---		---	---	---	---
2046	Vibration fatigue	Non-operating		---	---	---	---
2006	Constant acceleration (centrifugal)	20,000G Orientations X1, Y1, Y2, Z1		---	---	---	---
	<u>End Point Tests:</u>						
	Same as for Subgroup 2 above						
	<u>Subgroup 4</u>		20				
2036	Terminal strength (lead fatigue)	Test Cond. E 3/		---	---	---	---
	<u>Subgroup 5</u>		20				
1041	Salt atmosphere (corrosion)	---		---	---	---	---
	<u>Subgroup 6</u>		10				
1031	High-temperature life(non-operating)	T _{stg} = +100°C t = 340 hrs 4/		---	---	---	---

TABLE II. GROUP B INSPECTION.- (Continued)

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST 1/	CONDITIONS	LTPD	SYMBOL	LIMITS		UNIT					
					MIN.	MAX.						
	<u>Subgroup 6-(Cont'd)</u>		10									
	<u>End Point Tests:</u>											
	3036	Collector-base cutoff current:						Bias Cond. D				
		2N464						$V_{CB} = -40Vdc$	I_{CBO}	---	-30	μA_{dc}
		2N465						$V_{CB} = -40Vdc$	I_{CBO}	---	-30	μA_{dc}
		2N467						$V_{CB} = -35Vdc$	I_{CBO}	---	-20	μA_{dc}
	3206	Small-signal short-circuit forward-current transfer ratio:						$V_{CB} = -6Vdc$				
		2N464						$I_E = 1 mA_{dc}$				
		2N465						$f = 1 kHz$				
		2N467							h_{fe}	10	41	---
					h_{fe}	20	82	---				
					h_{fe}	83	325	---				
	1026	<u>Subgroup 7</u>										
		Steady state operation life:		$T_A = +25^{\circ}C$								
				$t = 340 hrs$								
				$P_T = 150 mW$								
	$V_{CB} = -35Vdc$											
		<u>End Point Tests:</u>										
		Same as for Subgroup 6 above										

1/ See 3.4 and 4.3.2 herein.

2/ Per Method 112 in Standard MIL-STD-202.

3/ Electrical rejects from the same lot under evaluation may be used for this test.

4/ See 4.2.4 herein.

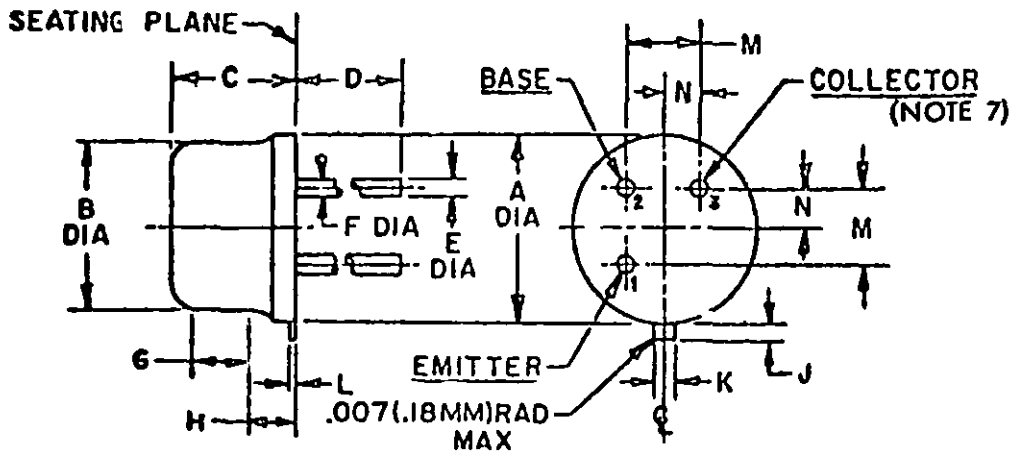
TABLE III. GROUP C INSPECTION. 1/

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST 2/	CONDITIONS	LTPD	SYMBOL	LIMITS		UNIT
					MIN.	MAX.	
1031	<u>Subgroup 1</u>		$\lambda = 10$				
	High-temperature life (non-operating)	$T_{stg} = +100^{\circ}\text{C}$ $t = 1000 \text{ hrs}$ 3/		---	---	---	---
	<u>End Point Tests:</u>						
3036	Collector-base cutoff current:	Bias Cond. D	$\lambda = 10$				
	2N464	$V_{CB} = -40\text{Vdc}$		I_{CBO}	---	-30	μAdc
	2N465	$V_{CB} = -40\text{Vdc}$		I_{CBO}	---	-30	μAdc
	2N467	$V_{CB} = -35\text{Vdc}$		I_{CBO}	---	-20	μAdc
3206	Small-signal short-circuit forward-current transfer ratio:	$V_{CB} = -6\text{Vdc}$ $I_E = 1 \text{ mAdc}$ $f = 1 \text{ kHz}$					
	2N464			h_{fe}	10	41	---
	2N465			h_{fe}	20	82	---
	2N467			h_{fe}	83	325	---
	<u>Subgroup 2</u>						
1026	Steady state operation life:	$T_A = +25^{\circ}\text{C}$ $t = 1000 \text{ hrs}$ $V_{CB} = -35\text{Vdc}$ $P_T = 150\text{mW}$ 3/		---	---	---	---
	<u>End-Point Tests:</u>						
	Same as for Subgroup 1 above						

1/ See 4.2.5 herein.

2/ See 3.4 and 4.3.2 herein.

3/ See 4.2.4 herein.

**NOTES:**

1. Metric equivalents (to the nearest 01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
2. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
3. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
4. Variations on Dim. B in this zone shall not exceed .010 (.25 mm).
5. Outline in this zone is not controlled.
6. When measured in a gaging plane .054+.001 (1.37 mm + .03 mm) below the seating plane of the transistor max dia leads shall be within .007 (.18 mm) of their true location relative to a maximum width tab. Smaller dia leads shall fall within the outline of the max dia lead tolerance.
7. All leads electrically isolated from case.
8. Measured from the maximum diameter of the actual device.
9. All three leads.

DIMENSIONS					NOTES
LTR	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.335	.370	8.51	9.40	
B	.305	.335	7.75	8.51	
C	.240	.260	6.10	6.60	
D	1.500	1.750	38.10	44.45	7,9
E	.016	.021	.41	.53	2,9
F	.016	.019	.41	.48	3,9
G	.100	---	2.54	---	4
H	---	---	---	---	5
J	.029	.045	.74	1.14	8
K	.028	.034	.71	.86	
L	.009	.125	.23	3.18	
M	.1414 Nom		3.59 Nom		6
N	.0707 Nom		1.80 Nom		6

Figure 1. Outline and Dimensions.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery. - Preparation for delivery and the inspection of Preparation for Delivery shall be in accordance with Specification MIL-S-19500.

6. NOTES

6.1 Notes. - The notes included in Specification MIL-S-19500, with the following additions or exceptions, are applicable to this specification.

6.2 Application guidance and supersession information. -

- a. The transistors conforming to requirements of this document issue are recommended as replacements (having superior-controlled characteristics) for the transistors covered by previous issue(s) of, respectively, this document and the following superseded documents, all as listed below:

MIL-T-19500/49B (Sig C), 3 Feb 1959--Transistor, Type 2N464

MIL-T-19500/50A (Sig C), 3 Feb 1959--Transistor, Type 2N465

MIL-T-19500/52B (Sig C), 3 Feb 1959--Transistor, Type 2N467

- b. To insure proper equipment-circuit application, particular attention should be given to the differential voltage and current-gain ratings and performance characteristics pertinent to the individual transistor types covered herein.

6.3 Ordering data. -

- a. Terminal-lead length: See 3.3.3 herein.
- b. Terminal-lead material and finish: See 3.3.4 herein.

6.4 Qualification. - With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List (QPL)-19500, whether or not such products have actually been so listed by that date. Information pertaining to qualification of products covered by this specification should be requested from the Commanding General, U. S. Army Electronics Command, Fort Monmouth, New Jersey 07703, Attention: AMSEL-PP-EM-2.

6.5 Revision (document) changes. - Revision-letter symbols are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes. (See 6.2a supersession information, above.)

Custodian:
Army-EL

Preparing activity:
Army-EL

Project No. 5961-A010